BC Electric Market Overview

Central Asia Delegation

30 January 2013

Doug Robinson
Canadian Entity Secretary
BC Hydro - Generation

Columbia River Treaty Organization

CANADIAN GOVERNMENT
Ministry of Foreign Affairs & Trade
Ministry Natural Resources

BRITISH COLUMBIA GOVERNMENT

TREATY

UNITED STATES GOVERNMENT
Department of State
Department of Army
Department of Energy

PERMANENT ENGINEERING BOARD *
CANADIAN UNITED STATES

CANADIAN ENTITY
for Art.XIV(2)*

CANADIAN ENTITY *

United States ENTITY *

PEB ENGINEERING COMMITTEE ***
CANADIAN UNITED STATES

CANADIAN COORDINATOR & SECRETARY **

OPERATING COMMITTEE **
CANADIAN UNITED STATES

United States COORDINATOR & SECRETARY **

HYDROMETEOROLOGICAL COMMITTEE **
CANADIAN UNITED STATES

* Established by TREATY

** Established by ENTITIES

*** Established by PEB

Doug Robinson, Canadian Entity Secretary

Canada Facts

- **Population: ~ 34.3 millio**
- **10 Provinces, 3 Territorie**
- **Confederation: 1 July 186**
- **Government: Parliamentary Democracy, Constitutional Monarchy**
- **Languages: English, French [Primarily Quebec]**
- **Area: ~10 million km² [2nd largest after Russia; 6 time zones; borders 3 oceans]**
- **Capital: Ottawa, Ontario [coldest capital in world]**
- **Border with US is longest undefended border.**
- **Gross Domestic Product ~ $1.4 Trillio**
- **Electrical Capacity ~ 131,000 MW**

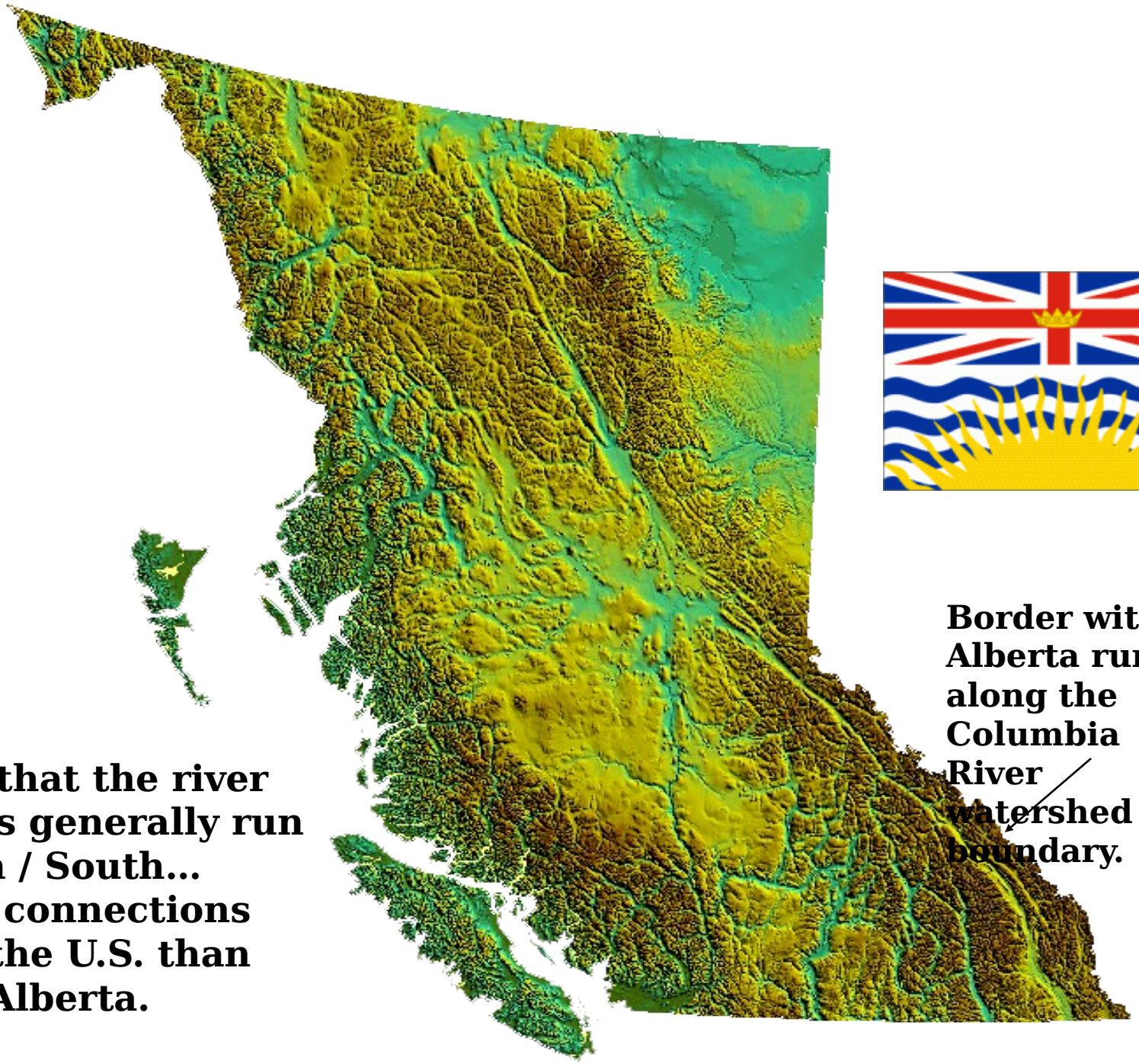
British Columbia (B.C.) Facts

- **Population: ~ 4.4 million [3rd]**
- **British Colony: 19 November 185**
- **Entered Confederation: 20 July 18**
- **Area: ~0.95 million km² [4 x Great Britain]**
- **Vancouver Island ~ size of Belgium.**
- **B.C. was named after the Columbia River… after the initial proposal, “New Caledonia” was rejected.**
- **Capital: Victoria, on Vancouver Island.**
- **Vancouver: Named after Captain Geo Vancouver; Named “World’s most liv**
- **Electrical Capacity ~ 12,000 MW**

BC Hydro Facts

BC hydro
FOR GENERATIONS

- **A Provincially-owned Crown Corporation.**
- **Serves ~95% of BC's population [FortisBC serves rest]**
- **~ 1.8 million customers.**
- **~ 5800 employees**
- **Domestic Revenues ~ $4 billion /year**
- **Generation varies from 42,000 GWh – 52,000 GWh/year**
- **Installed Capacity ~ 12,000 MW**
- **Rates are ~ 4th lowest in North America [lower include: Quebec Hydro; Manitoba Hydro; Seattle City Light]**
- **Rates: Residential 77 $/MWh; Commercial 69 $/MWh; Large Industrial 45 $/MWh**
- **57,700 km of Distribution lines**
- **18,800 km of Transmission lines**

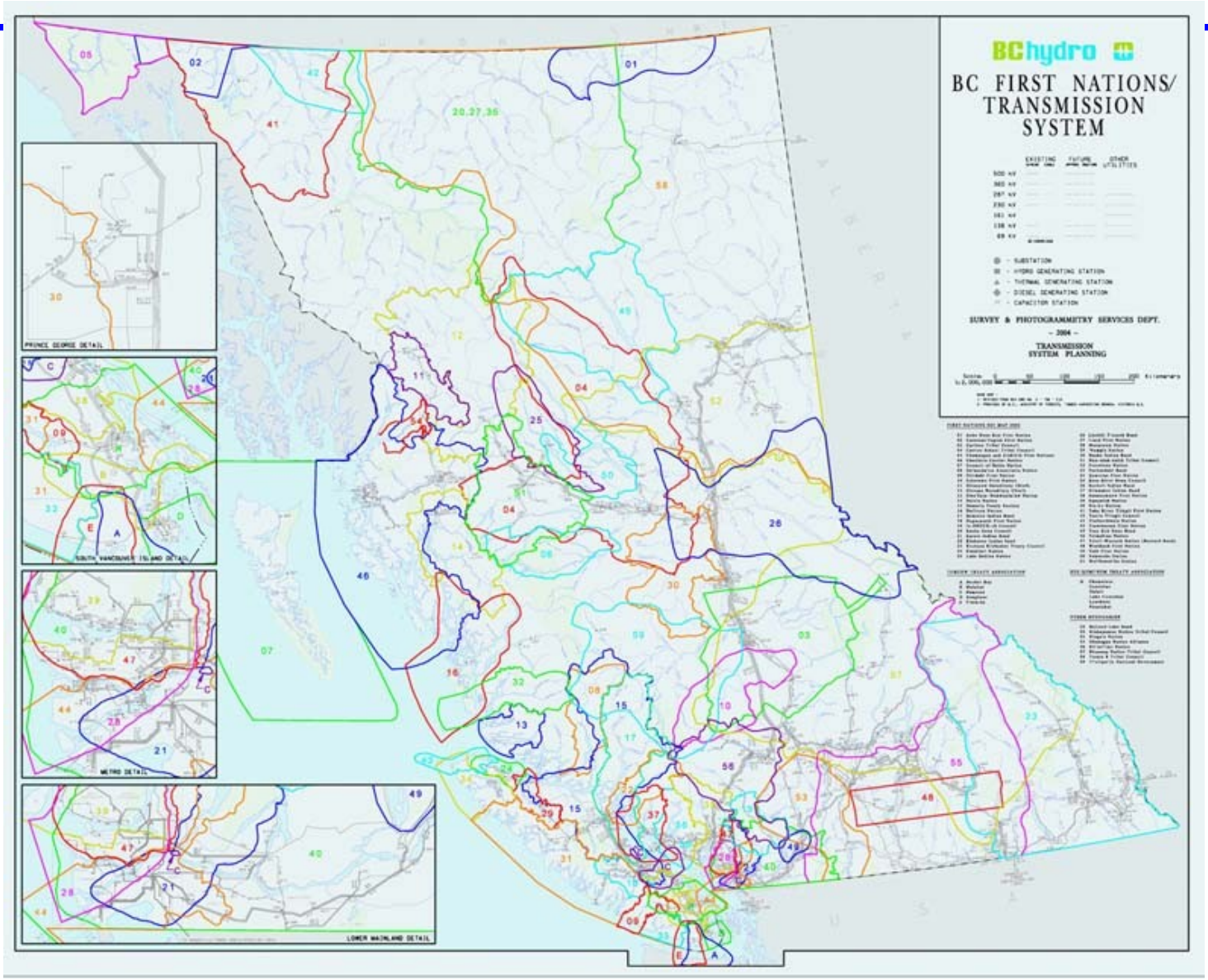


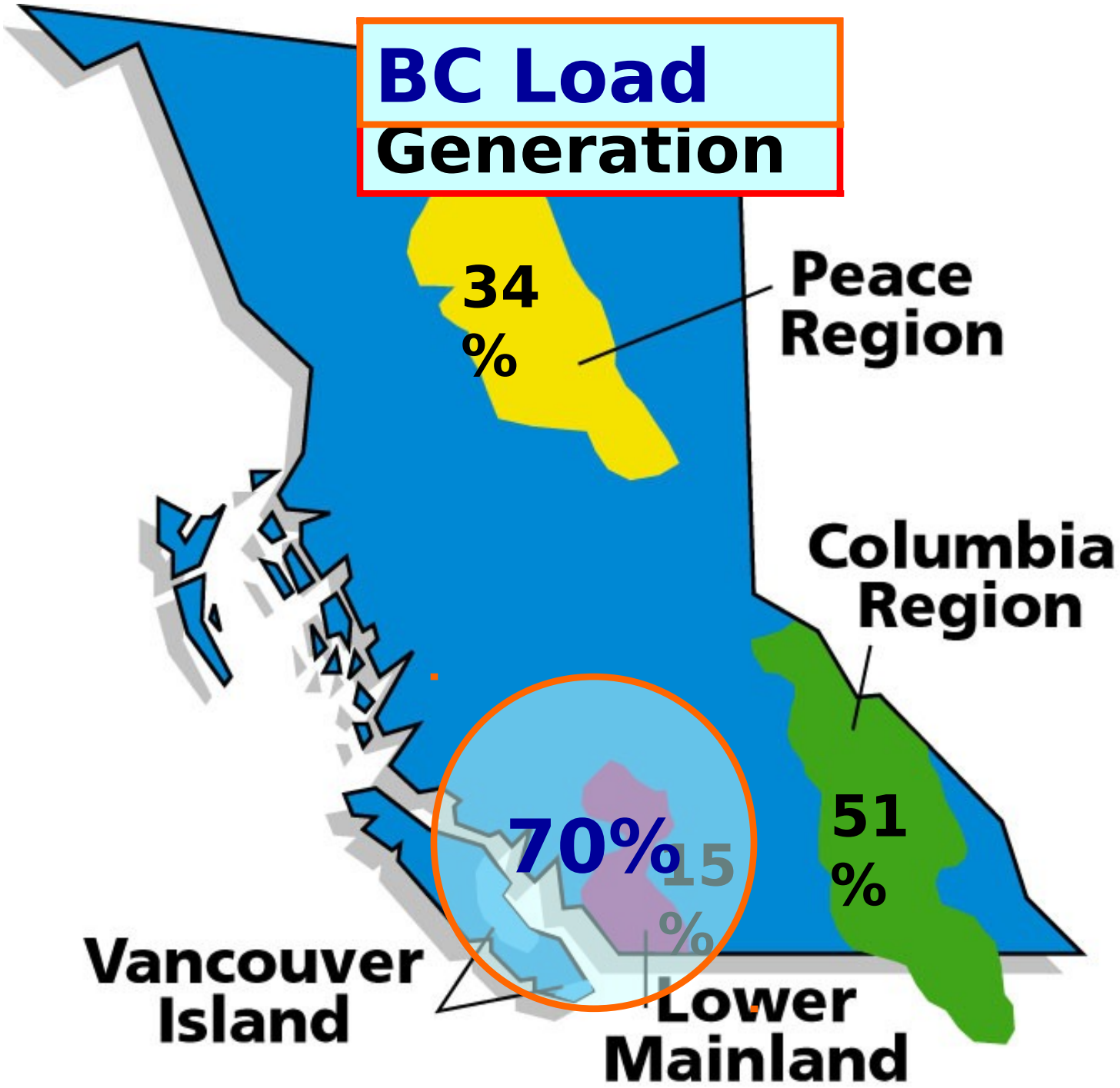
Note that the river basins generally run North / South… more connections with the U.S. than with Alberta.

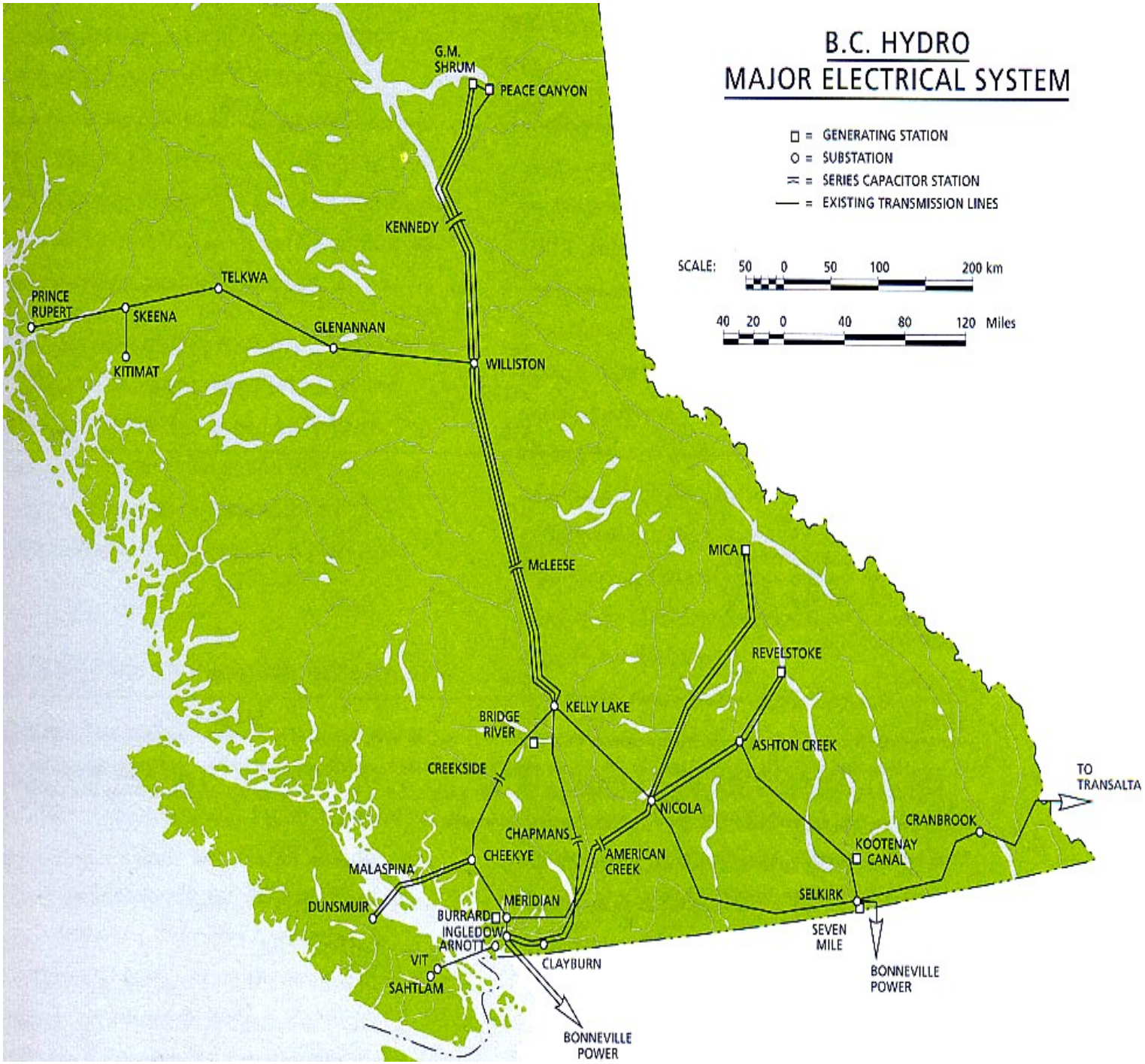
Border with Alberta runs along the Columbia River watershed boundary.

PACIFIC
MACKENZIE
Vancouver
Portland
COLUMBIA
Ottawa

First Nations Territories




BC Load
Generation
34
%
Peace
Region
Columbia
Region
51
%
70%
15
%
Vancouver
Island
Lower
Mainland


B.C. HYDRO
MAJOR ELECTRICAL SYSTEM
□ = GENERATING STATION
○ = SUBSTATION
= = SERIES CAPACITOR STATION
— = EXISTING TRANSMISSION LINES
SCALE: 50 0 50 100 200 km
40 20 0 40 80 120 Miles
G.M. SHRUM
PEACE CANYON
KENNEDY
TELKWA
PRINCE RUPERT
SKEENA
GLENANNAN
KITIMAT
WILLISTON
McLEESE
MICA
REVELSTOKE
KELLY LAKE
BRIDGE RIVER
ASHTON CREEK
CREEKSIDE
TO TRANSALTA
NICOLA
CRANBROOK
CHAPMANS
KOOTENAY CANAL
CHEEKYE
AMERICAN CREEK
MALASPINA
SELKIRK
MERIDIAN
DUNSMUIR
BURRARD
INGLEDOW
ARNOTT
SEVEN MILE
VIT
CLAYBURN
SAHTLAM
BONNEVILLE POWER
BONNEVILLE POWER

BC Hydro's Domestic Load

Domestic load is highest during:

-> winter months - due to colder temperatures and shorter days (heating, lighting, and appliance loads)

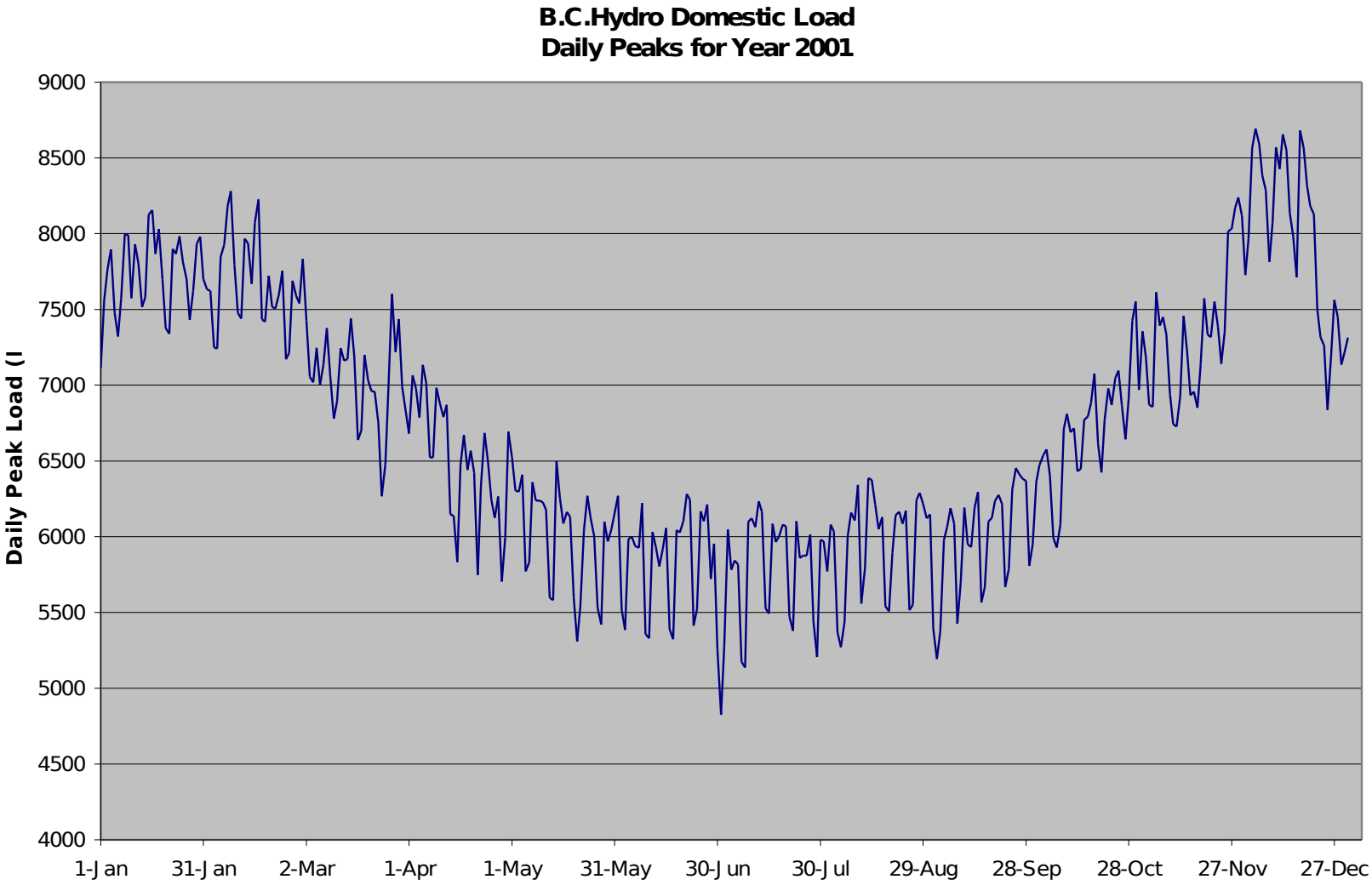
-> weekdays - due to higher industrial and commercial loads

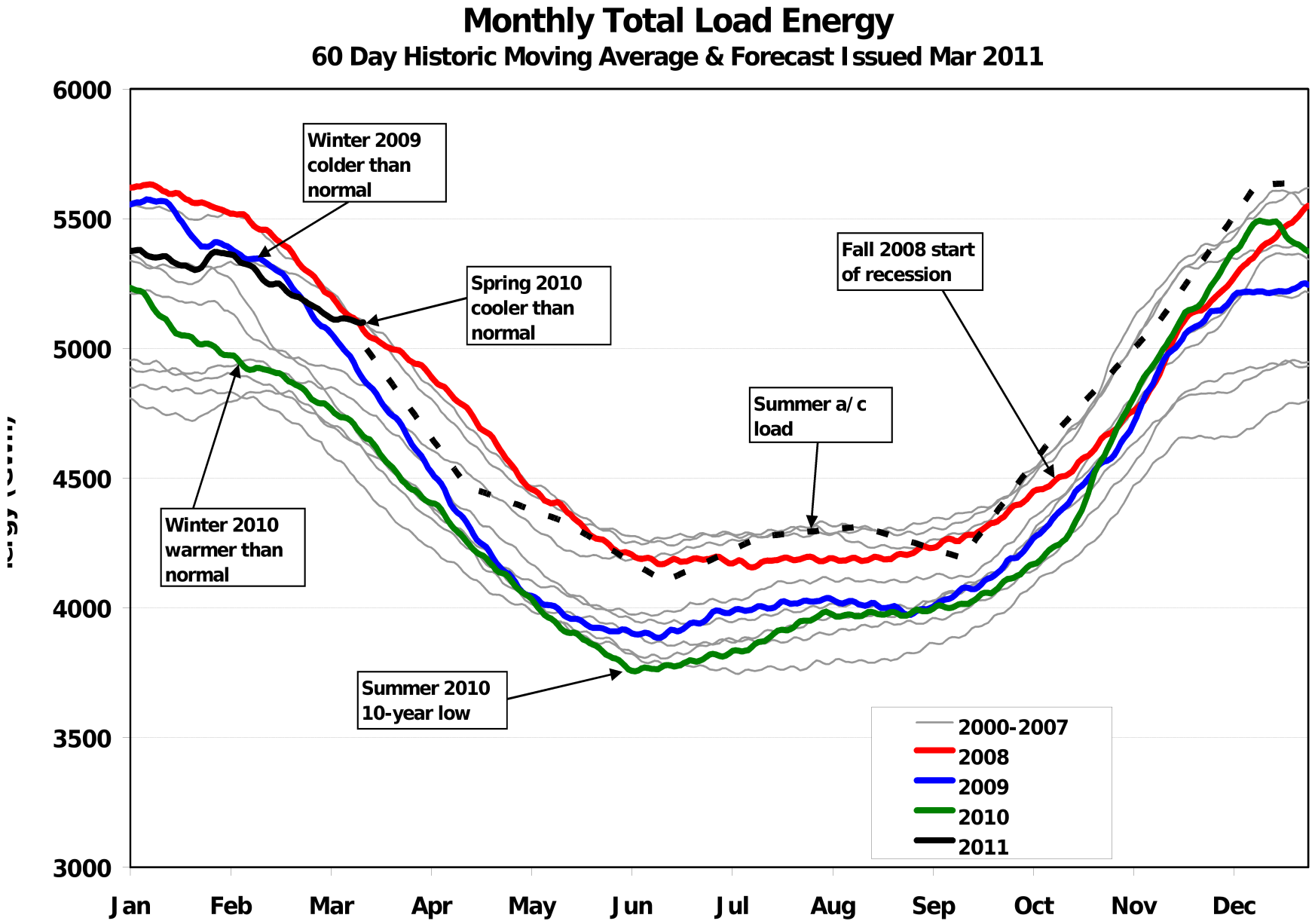
-> daytime and evening hours - due to higher industrial and commercial loads as well as residential loads (especially in late afternoon and evening hours)

BC Hydro's peak load typically occurs on a very cold weekday in December or January between the hours of 5 and 6 pm (heating, lighting, electric stoves, etc.)

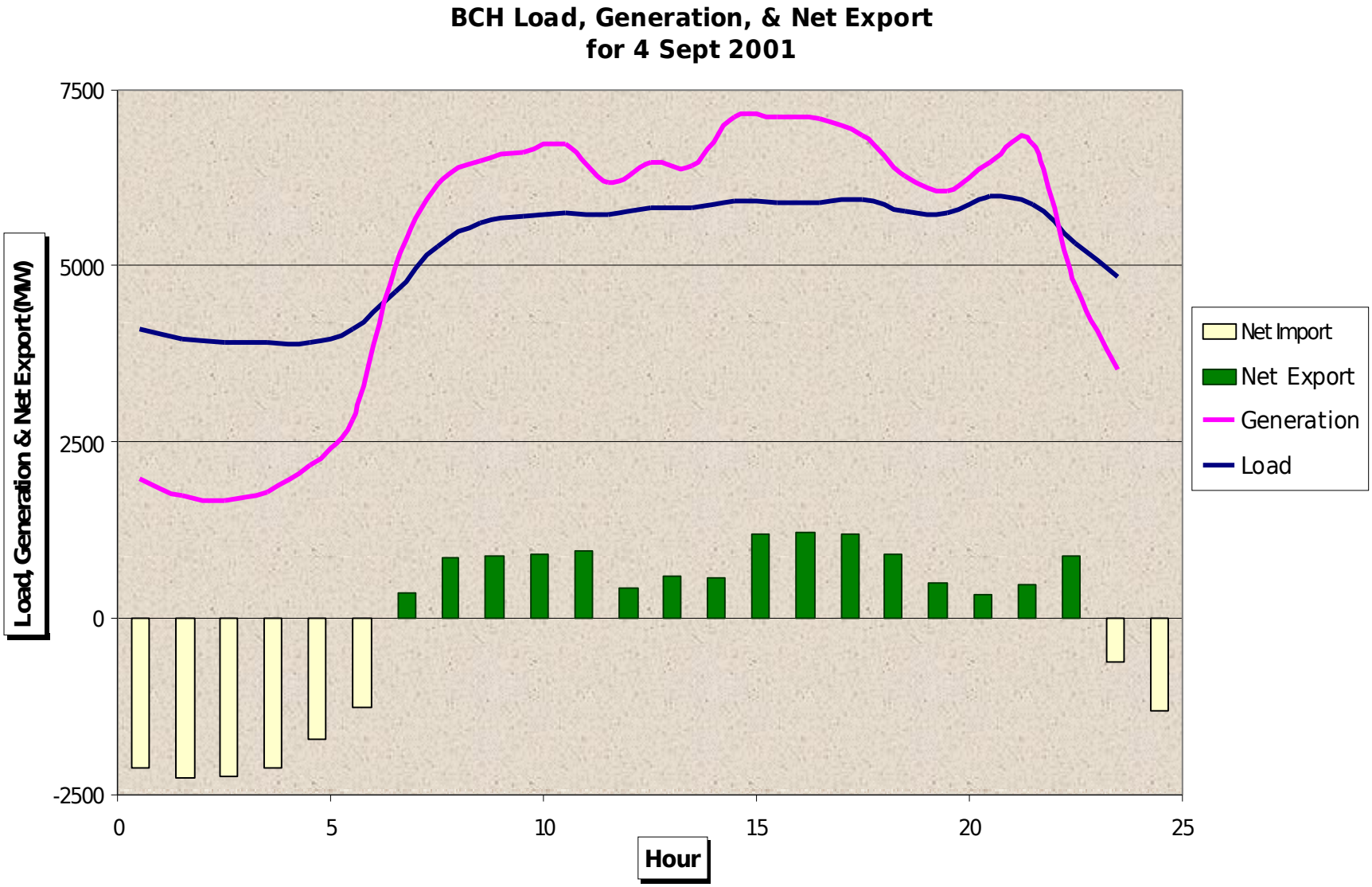
<u>Remember</u> -- At all times, supply (generation + imports) must equal demand (domestic load + exports)

BC Hydro Domestic Load - annual pattern
- load and temperature inversely correlated




Monthly Total Load Energy
60 Day Historic Moving Average & Forecast Issued Mar 2011
6000
5500
5000
4500
4000
3500
3000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Winter 2009 colder than normal
Spring 2010 cooler than normal
Fall 2008 start of recession
Summer a/c load
Winter 2010 warmer than normal
Summer 2010 10-year low
2000-2007
2008
2009
2010
2011

BC Hydro Domestic Load, Generation, & Market Activity - typical daily pattern



B.C.Hydro & Powerex - description of markets

U.S. Pacific Northwest (~ 50% hydropower)

- generation patterns dominated by Columbia R runoff patterns and operational restrictions (numerous fisheries issues) … 11 powerplants on U.S. mainstem Columbia river plus many others on tributaries
- domestic load patterns very similar to BCH
- gas-fired generation sets the market price 75% of time

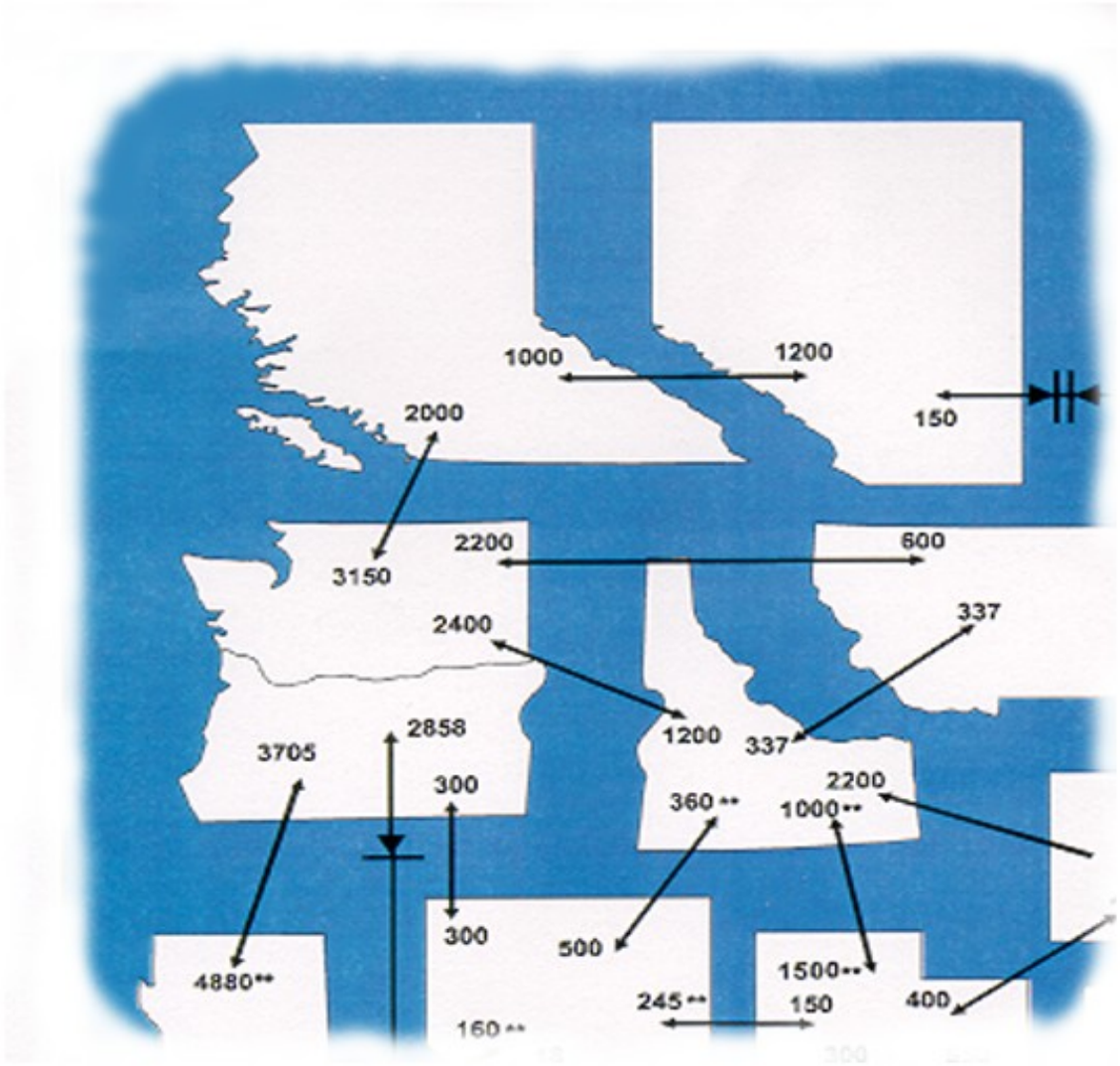
California and other U.S. Southwest

- good summer market due to air-conditioning load
- in winter, California sells energy to BCH and Northwest

Alberta

- base load is coal-fired generation
- gas-fired generation usually sets market price
- winter temperatures more extreme than in BC

Western North America - Transmission connections



B.C.Hydro's Interconnections - Electrical Coordination

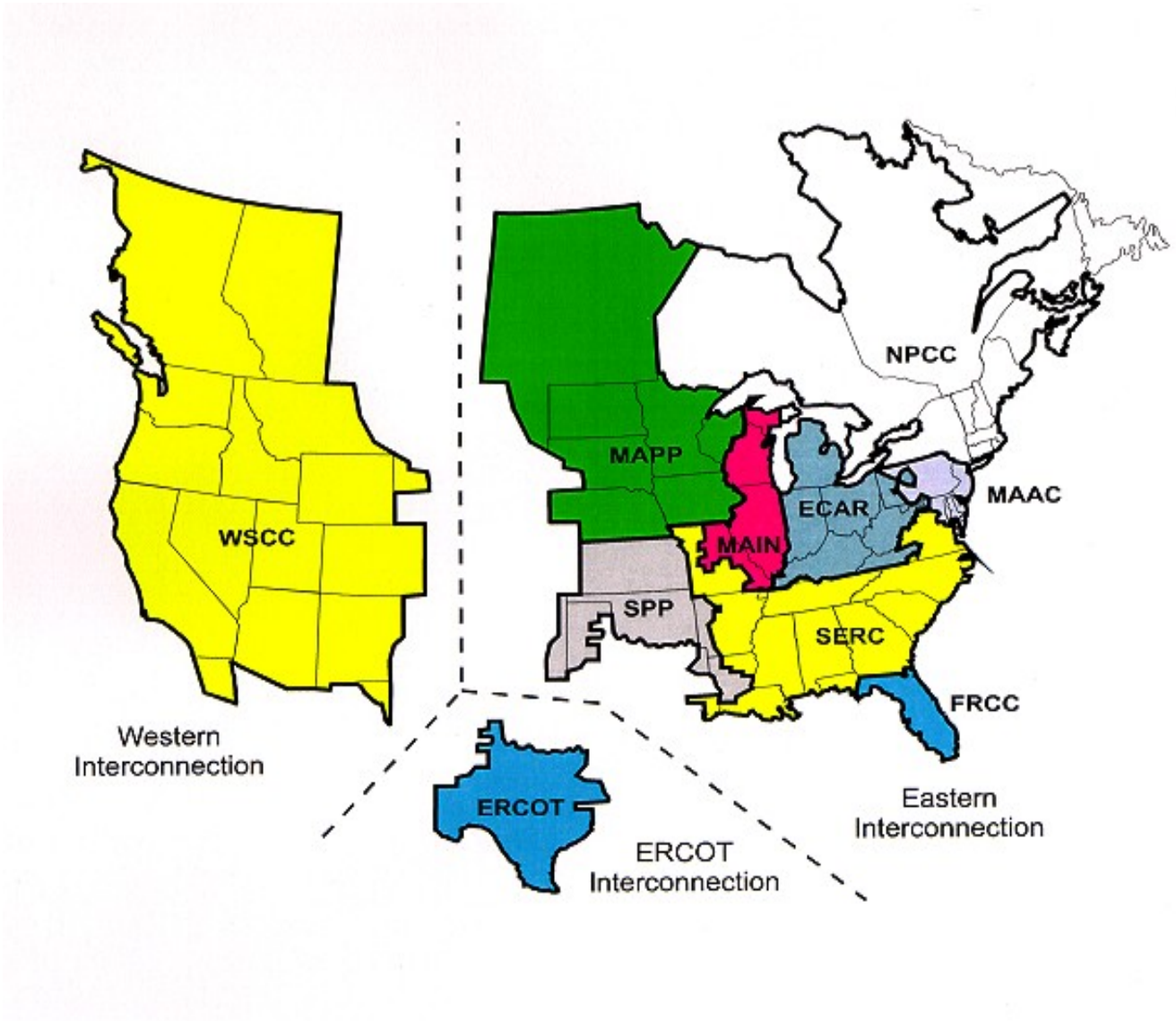
- **Western Electrical Coordination Council (WECC) and Northwest Power Pool (NWPP) formed to provide more stable electrical networks in western North America**

- **protects the reliability of the electrical grid while allowing economic trade in electricity**

- **all WECC members are required to carry "operating reserve", i.e. unloaded and reserved generating capacity that is available to help neighbouring utilities during a disturbance**

- **WECC operating reserve requirement for hydroelectric projects:**
  2.5 % of generation spinning +
  2.5 % of generation available within 10 minutes

North American Electrical Grid



Electricity is Unique

- **Bulk electricity is the only commodity that can not be directly stored (economically).**
- **Electricity production must *exactly* = aggregate load every instant, all the time!**
  - [No other commodity has this rigid requirement!]
- **Electricity users expect supply on immediate demand, at constant voltage and frequency.**
- **Failure to match load leads to system-wide frequency, voltage and stability problems.**
- **Critical need to exactly match load results in very high price volatility [the highest]!**

BC's Electric System is Unique

B.C.

- **90% Hydro (many with significant storage)**
- **10% Thermal (Natural Gas)**
- **Low cost and flexible!**

North America

- **56% Coal**
- **22% Nuclear**
- **10% Hydro (many with limited storage)**
- **9% Natural Gas**
- **3% Oil**

Hydro vs Thermal Generation

Hydro Project

- **High initial cost**
- **Low operating cost**
- **Energy limited and variable![~10,000 GWh variation!]**
- **Fast starting / stopping / ramping**
- **No emissions**
- **Hydro is Flexible!**

Thermal Project

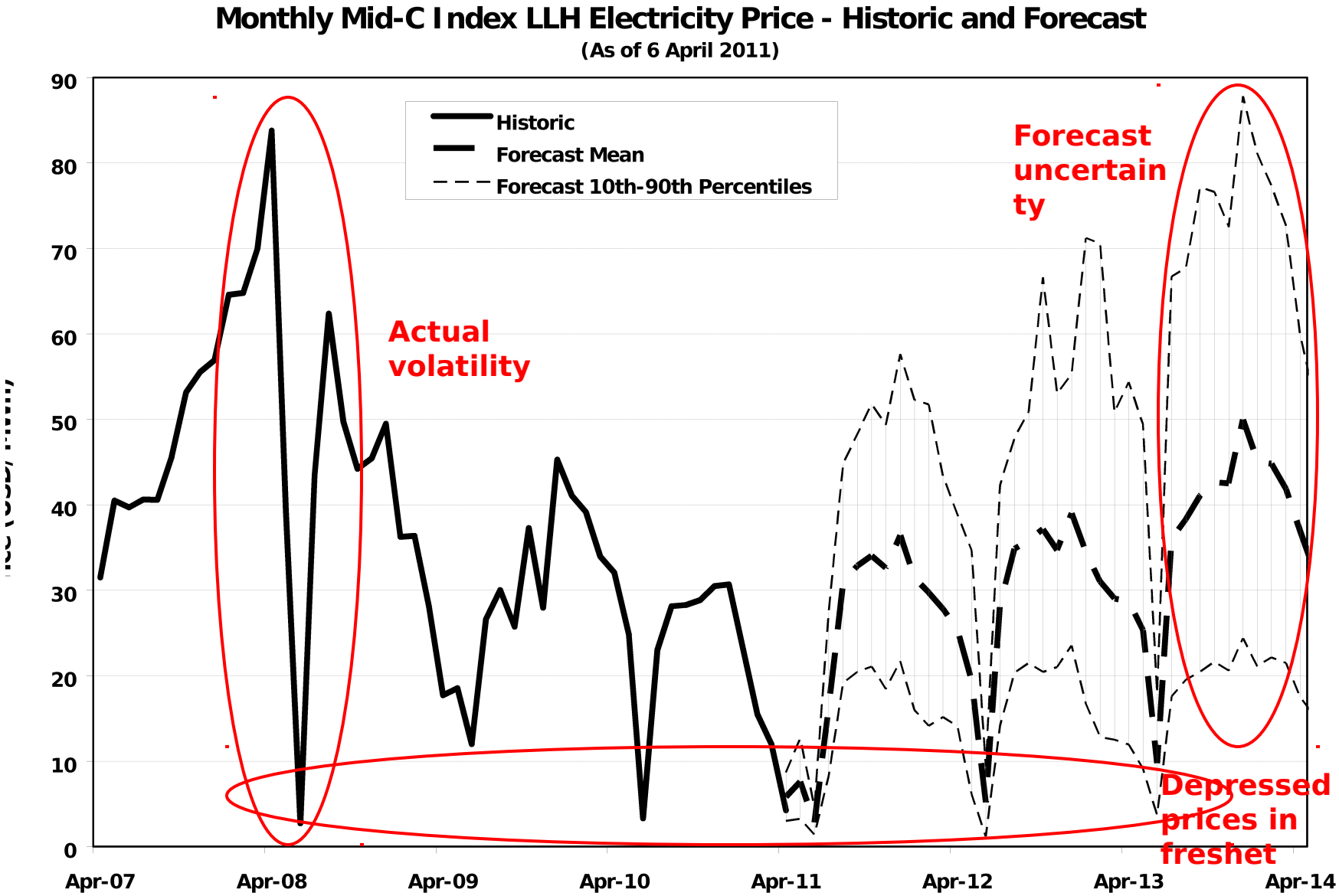
- **Lower initial cost**
- **High operating cost**
- **Generally not energy limited**
- **Slow starting / stopping / ramping**
- **Emissions vary with fuel and process**
- **Hot machinery is not!**

Hourly Prices are Volatile

Hourly Power Pools are operating in Alberta and California (now closed):

- Generators submit hourly ‘sell’ bids into Pool.
- Bids for each hour are stacked from lowest to highest price.
- Hourly clearing price is determined where supply = demand.
- Clearing price is paid to all successful bidders!

Hourly prices established are highly visible and objective, but are very volatile!


Monthly Mid-C Index LLH Electricity Price - Historic and Forecast
(As of 6 April 2011)
Historic
Forecast Mean
Forecast 10th-90th Percentiles
Actual volatility
Forecast uncertainty
Depressed prices in freshet
90
80
70
60
50
40
30
20
10
0
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14

Historical $ Volatility: Electricity is Highest

	Standard Deviation	Min	Max	Range
Electricity (PJM)	32%	-261%	278%	539%
Henry Hub Natural Gas	4.3%	31%	21%	52%
Heating Oil	3.6%	-47%	23%	70%
Coffee	2.9%	-13%	21%	34%
WTI Crude Oil	2.6%	-17%	10%	27%
Copper	1.3%	-5%	7%	12%

Source: http://www.gasfoundation.org/ResearchStudies/VolStudyCh2.pdf